ALUMINUM

Project Fact Sheet

Continuous Severe Plastic Deformation

Benefits

The potential benefits of this technology include:

- Full-scale industrial implementation of the results of this project will lead to energy savings in excess of 800 billion Btu per year
- Increased metal yield will result in two percent lower metal waste
- Lighter components due to the increased strength of ultrafine grained material

Applications

The use of ultrafine grained material is very attractive as machining, forging or extrusion stock. Its improved strength and ductility properties influence both manufacture- and service-related properties. Full-scale industrial implementation of this technology will substantially expand the use of aluminum forgings and extrusions.

Continuous severe plastic deformation (CSPD) processing of aluminum alloys

Ultrafine grained material allows the design and manufacture of aluminum components that use less metal and require fewer manufacturing steps. This provides energy and manufacturing cost savings. Several techniques for producing ultrafine grained materials are currently being investigated. These techniques are limited in their ability to produce the size and quantities of material needed for commercial use. One technique to produce ultrafine grained materials is the Equal Channel Angular Extrusion (ECAE) process. This technique is a multi-step batch process that produces small cross-section, short-length stock, which severely limits its commercialization. The Continuous Severe Plastic Deformation (CSPD) process will overcome the limitations of ECAE by producing large cross-section, continuous-length stock.

Project partners will develop the CSPD process for the production of continuous long lengths of bulk ultrafine grained aluminum alloys. Partners will demonstrate its feasibility in the laboratory and also demonstrate the advantages and use of the ultrafine grained material under industrial conditions. Using the CSPD process in place of conventional processes, and during secondary and finishing operations, will provide significant energy and cost benefits.

CSPD Aluminum Alloy

Severe plastic deformation die with a partially deformed sample shown on left. Top right shows a finite element (FE) prediction of strain distribution on the sample. Ultrafine grained aluminum alloy 1050 produced by ECAE shown in the micrograph.

Micrograph from "Characteristics of Submicron Grain Structure Formed in aluminum by Equal Channel Angular Extrusion" P.L. Sun, P.W. Kao, C.P. Chang, MSE A283 (2000) 82-85. Reproduced with permission from Prof. P.W. Kao.

Project Description

Goals: The primary goals of this project are to:

- Demonstrate that a continuous severe plastic deformation process produces ultrafine grained stock material of substantial length and diameter (>30 mm or ~1.25 inches) at a reasonable cost.
- Demonstrate that ultrafine grained material results in energy and cost savings during forging.
- Transfer the technology to commercial practice.

Progress and Milestones

- Design and build a sub-scale CSPD machine that will produce long ultrafine grain aluminum alloys of at least 30 mm (~1.25 inches) in diameter.
- Demonstrate a CSPD process.
- Demonstrate that the ultrafine grain material will provide the expected cost and energy benefits. The project partners will prepare the initial material and then manufacture large-size ECAE dies to produce ultrafine grain material which will be used to make larger-size forgings.
- Transfer the new technology to industry.

Commercialization Plan

Aluminum forging, extrusion, and sheet fabrication constitutes 40 percent of Intercontinental Manufacturing's business. Intercontinental Manufacturing will play a key role in the transfer of this technology working with its customers and suppliers, while Edison Materials Technology Center (EMTEC) will lead the commercialization process. Commercialization will proceed as follows:

- Industry partners will have the opportunity to learn and verify the benefits of the CSPD process and the materials it produces once it is developed and prototype equipment is built at Oak Ridge National Laboratory. EMTEC will lead the effort to develop the market for the material and process.
- Intercontinental Manufacturing will build the first prototype of the scaled-up (commercial production capacity) processing equipment.
- The process and equipment will then be licensed to producers and others in the aluminum industry.

PROJECT PARTNERS

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Washington, D.C. 20585

October 2001